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IMAGE PROCESSING AND PRODUCTS FOR THE MAGELLAN MISSION TO VENUS. Jerry Clark, Doug Alexander, Paul Andres, Scott Lewicki, and Myche McAuley, Magellan Image Data Processing Team, Jet Propulsion Laboratory, Mail Stop 168-514, 4800 Oak Grove Drive, Pasadena CA 91109, USA.

The Magellan mission to Venus is providing planetary scientists with massive amounts of new data about the surface geology of Venus. Digital image processing is an integral part of the ground data system that provides data products to the investigators. The mosaicking of synthetic aperture radar (SAR) image data from the spacecraft is being performed at JPL's Multimission Image Processing Laboratory (MIPL). MIPL hosts and supports the Image Data Processing Subsystem (IDPS), which was developed in a VAXcluster environment of hardware and software that includes optical disk jukeboxes and the TAE-VICAR (Transportable Applications Executive-Video Image Communication and Retrieval) system. The IDPS is being used by processing analysts of the Image Data Processing Team to produce Magellan image data products. Data arrive at the IDPS via the fiber optic Imaging Local Area Network from the SAR Data Processing Subsystem that correlates raw SAR data into image data. The input SAR image swaths, called F-BIDRs (Full-resolution Basic Image Data Record), are long, thin swaths of imagery covering an area on the surface about 20 km in width by about 17,000 km in length, extending from the north pole to near the south pole of Venus. Systematic procedures were written for the automatic mosaicking of multiple orbits of data into image frames covering predetermined regions of the planet. Algorithms were developed to perform such functions as the correction of radiometric differences at the edges of adjacent orbits and the automatic tiepointing of overlapping data to correct for navigational errors between orbits. After mosaicking, the images are contrast enhanced, annotated, and masked to create photo products for scientific analysis. Other versions of mosaics are created from reduced resolution image swaths. Depending on the product, the data are output from the MIPL as archive tapes; working WORM (Write-Once-Read-Many) optical disks; premastered tapes for stamping, by a vendor, of CD-ROMs (Compact-Disc-Read-Only-Memory) that are used to distribute mosaics and ancillary data to the scientific community; and exposed film that is used for the production of prints and copy negatives. Numerous special products have been made at the request of the investigators, including SAR mosaics merged with non-SAR data (such as altimetry and radiometric emissivity data) that are displayed as color composites and stereo anaglyphs that use SAR data collected at different look-angles to view surface topography through stereo parallax. In addition, mosaicked data are used to make other products, including terrain rendering that shows SAR mosaics combined with digital elevation data in perspective views and videos that use thousands of incremented rendered scenes to create simulated flights over the surface of Venus.

(This work is being performed at JPL, California Institute of Technology, under contract with NASA.)

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THE THERMOSPHERE AND IONOSPHERE OF VENUS. T. E. Cravens, Department of Physics and Astronomy, University of Kansas, Lawrence KS 66045, USA.

Our knowledge of the upper atmosphere and ionosphere of Venus and its interaction with the solar wind has advanced dramati-

cally over the last decade, largely due to the data obtained during the Pioneer Venus mission and to the theoretical work that was motivated by this data. Most of this information was obtained during the period 1978 through 1981, when the periapsis of the Pioneer Venus Orbiter (PVO) was still in the measurable atmosphere. However, solar gravitational perturbations will again lower the PVO periapsis into the upper atmosphere in September 1992, prior to the destruction of the spacecraft toward the end of this year. The physics and chemistry of the thermosphere and ionosphere of Venus will be reviewed in this paper. The book entitled *Venus Aeronomy* [1] contains several chapters that together provide a good overview of this subject.

The neutral atmosphere is primarily composed of carbon dioxide, but for altitudes above about 160 km atomic oxygen, which is produced via photodissociation of CO₂ by solar photons, becomes the dominant neutral species. The PVO neutral mass spectrometer has provided most of our information on the composition of the Venus thermosphere. The thermosphere of Venus is quite cold in comparison with Earth's thermosphere with an exospheric temperature on the dayside of T_{ex} ≈ 300 K, whereas at Earth T_{ex} ≈ 1500 K. The nightside thermosphere of Venus is extremely cold with T_{ex} ≈ 100 K; it has been suggested, in fact, that this region of the atmosphere be called the "cryosphere" rather than the thermosphere. It is not fully understood why the upper atmosphere of Venus is so cold, although part of the answer is contained in the CO₂ 15-μm cooling mechanism and also in the nature of the thermosphere dynamics. Thermospheric wind speeds of several hundred meters per second have been theoretically calculated for altitudes above about 150 km, and indirect observational evidence, such as compositional gradients, supports the validity of these calculations.

The exobase of Venus is located at about 180 km; above this altitude, in the exosphere, neutral atoms and molecules largely follow ballistic trajectories. Both atomic oxygen and atomic hydrogen are abundant in the Venus exosphere. The H density is about 10⁵ cm⁻³ on the dayside and about 10⁷ cm⁻³ on the nightside. Two populations of exospheric H exist at Venus: (1) a cold thermal component and (2) a hot (i.e., an effective temperature of ≈1200 K) nonthermal component. The hot hydrogen is thought to be mainly produced by the charge exchange of hot H⁺ ions with neutral H and O atoms. Both cold and hot populations of atomic oxygen also exist in the Venus exosphere, and the nonthermal hot population has a larger density than the cold population for altitudes above about 300 km. The hot oxygen corona, as it is called, was observed by the ultraviolet spectrometer onboard PVO via resonantly scattered solar 130.4-nm photons. The major source of hot oxygen is the dissociative recombination of ionospheric O₂⁺ ions. Hot oxygen plays an important role in the solar wind interaction with Venus, because photoionization of oxygen atoms that are present out in the Venus magnetosheath creates heavy ions that "mass load," and thus slow down, the solar wind flow.

The ionosphere of Venus forms due to the ionization of neutrals. Photoionization by solar extreme ultraviolet (EUV) photons is the main ionization process, although some contribution is also made by electron impact ionization by photoelectrons on the dayside and by "auroral" electrons on the nightside. It should be noted that superthermal electrons appear to be precipitating into the nightside atmosphere of Venus, generating emissions observed by the PVO ultraviolet spectrometer and also creating ionization. However, the Venus aurora is very weak in comparison with the terrestrial aurora, and is thought to be caused by relatively low energy electrons (i.e., energies of ≈100 eV or less, whereas auroral electrons at Earth have energies of thousands of eV).